# Executive Summary

This Executive Summary presents an overview of the Human Health Risk Assessment (HHRA) of the Allied Paper, Inc./Portage Creek/Kalamazoo River (API/PC/KR) Superfund Site. Risks and hazards were in this HHRA estimated for five populations: (1) sport angler — central tendency assumptions (2) sport anglers — high-end assumptions; (3) subsistence anglers; (4) residents, and (5) recreationalists. In all cases, risks and hazards were associated with exposures to polychlorinated biphenyls (PCBs) released into the Kalamazoo River system. Exposures to PCBs may result primarily from ingestion of fish or by direct contact with PCB contaminated floodplain soils, or inhalation of dust and volatile emissions from floodplain soil near three former river dams. Such exposures were assessed quantitatively. Other potential exposure, including ingestion, waterfowl, and turtles, and direct contact with contaminated surface water were found to be inadequately characterized by available data.

## Regulatory Environment

This HHRA was developed separately from other regulatory decisions for protection of human health. A fish advisory is currently in place on parts of the Kalamazoo River and Portage Creek (MDCH 2000a). For the general population, on the Kalamazoo River between Morrow Pond Dam and Allegan Dam and on Portage Creek below Monarch Mill Pond, the advisory recommends no consumption of carp, catfish, suckers, smallmouth bass, and largemouth bass, and no more than one meal per week of all other species. For the general population, below Allegan Dam the advisory recommends no consumption of carp, catfish, and northern pike, no more than one meal per week of largemouth and smallmouth bass, and unlimited consumption of all other species.

For nursing mothers, pregnant women, women intending to have children, and children under 15 years of age, no consumption of any species is recommended for fish caught above Allegan Dam. For fish caught below Allegan Dam, the advisory recommends for women and children no consumption of carp, catfish, northern pike, smallmouth bass, and largemouth bass and suggests eating no more than one meal per month for all other species. Table E-1 presents the 2000 Michigan fish advisories for the API/PC/KR site. A survey of anglers on the Kalamazoo River was conducted by the Michigan Department of Community Health of the State of Michigan in 1994 (*Kalamazoo River Angler Survey and Biological Testing Study* [MDCH 2000b]). Despite existing advisories, this survey reported that anglers from Kalamazoo and Allegan Counties are eating on average two meals per month of various species including bass, catfish, panfish, bullheads, and carp taken from contaminated reaches of the river. More than 10 percent of anglers are eating more than one meal per week of these various species. This survey confirmed that the Kalamazoo River is an important recreational resource and, for certain subpopulations may serve as an important source of food.

**Table E-1 Michigan Fish Advisory for PCBs, API/PC/KR Site**

| Water Body | Species | General Population Length (inches) | | | | | | | | | Women and Children Length (inches) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 6-8 | 8-10 | 10-12 | 12-14 | 14-18 | 18-22 | 22-26 | 26-30 | 30+ | 6-8 | 8-10 | 10-12 | 12-14 | 14-18 | 18-22 | 22-26 | 26-30 | 30+ |
| Kalamazoo River (from Battle Creek to Morrow Pond Dam) | Carp | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| Kalamazoo River (from Morrow Pond Dam to Allegan Dam) and Portage Creek (below Monarch Mill Pond, Kalamazoo Co.) | Carp, Catfish, Suckers | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| | Largemouth and Smallmouth Bass | | | | | NC | NC | NC | NC | | | | | | NC | NC | NC | NC | |
| | All other species | ● | ● | ● | ● | ● | ● | ● | ● | ● | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| Kalamazoo River (below Allegan Dam) | Carp, Catfish | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC |
| | Largemouth and Smallmouth Bass | | | | | ● | ● | ● | ● | | | | | | NC | NC | NC | NC | |
| | Northern Pike | | | | | | | NC | NC | NC | | | | | | | NC | NC | NC |
| | All other species | UC | UC | UC | UC | UC | UC | UC | UC | UC | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

NC = No Consumption
UC = Unlimited Consumption
● = One meal per week
■ = One meal per month

# Risk Assessment Overview

An HHRA has five steps:

- Data Evaluation
- Toxicity Assessment
- Exposure Assessment
- Risk Characterization
- Uncertainty Analysis

In the Data Evaluation, available fish data collected in 1993 and 1997 were compiled and reviewed. Data were collected for several species from 11 Aquatic Biota Study Areas (ABSAs), including smallmouth bass, a representative sport fish, and carp, a representative bottom feeder. Data for these species from 1993 fish fillet samples were used in the HHRA.

While individual Aroclors were analyzed, the HHRA was based on total PCBs, as recommended by United States Environmental Protection Agency (EPA).

In the Toxicity Assessment, the potential health effects of PCBs are evaluated and toxicological benchmarks are identified which can be used to quantify cancer risks

and noncancer hazard. The potential health effects of PCBs include cancer, reproductive effects and immunological effects (ATSDR 1996).

The Exposure Assessment involves developing scenarios whereby people come into contact with contaminated media (sediments, soils, fish). While exposure to many media are likely to be taking place at the site, fish ingestion and contact with contaminated floodplain soils were the only exposure pathways for which a quantitative assessment of risk and hazard was conducted. Data were deemed inadequate to evaluate two exposure pathways: inhalation of particulate and vapor phase contamination, and ingestion of waterfowl and turtles.

Three exposure scenarios were developed for fish ingestion (Table E-2): (1) the sport anglers scenario — central tendency assumptions; (2) the sport angler scenario — high-end assumptions; and (3) the subsistence angler scenario. The difference between the three fishing scenarios is reflected in different fish ingestion rates, exposure durations, species consumed, and fractions of the total fish ingested that were from a contaminated source.

**Table E-2 Exposure Assumptions for Anglers**

| Assumption | Central Tendency Sport Angler | High-End Sport Angler | Subsistence Angler | Reference |
|---|---|---|---|---|
| Body Weight | 70kg | 70kg | 70kg | EPA 1997 |
| Fish Ingestion Rate | 0.015 kg/day (24 meals/year) | 0.078 kg/day (125 meals/year) | 0.11 kg/day (179 meals/year) | West 1993 |
| Fraction from Contaminated Source | 1.0 | 0.5 | 1.0 | |
| Exposure Frequency | 365 days/year | 365 days/year | 365 days/year | EPA 1997 |
| Exposure Duration Reproductive | 30 years (cancer) 30 years (noncancer) 2-7 years (reproductive) | 30 years (cancer) 30 years (noncancer) 2-7 years (reproductive) | 30 years (cancer) 30 years (noncancer) 2-7 years (reproductive) | EPA 1994 |
| Species | Smallmouth bass [1] (100%) & Smallmouth bass/Carp (76%) / (24%) | Smallmouth bass [1] (100%) & Smallmouth bass/Carp (76%) / (24%) | Smallmouth bass [1] (100%) & Smallmouth bass/Carp (76%) / (24%) | Site-Specific |
| Reduction Factor | 50% | 50% | 50% | Zabik 1995 |
| Absorption Efficiency | 100% | 100% | 100% | ATSDR 1996 |

[1] Smallmouth bass are used in the HHRA to represent a trophic level 4 fish (predator) and carp are used to represent a trophic level 3 fish (bottom feeder).

These assumptions are based on work previously conducted by EPA Region V on Manistique Harbor, Michigan; Saginaw Bay, Michigan; and the Lower Fox River, Wisconsin Superfund sites. Fish ingestion rates for the sport angler are based on the *Great Lakes Water Quality Initiative Technical Support Document for Human Health Criteria and Values* (EPA 1995).

Two scenarios were evaluated for floodplain soil exposures, the nearby resident scenario and the recreationalist scenario. Exposure assumptions used to evaluate these scenarios are summarized below:

**Table E-3 Residential Exposure Assumptions**

| Assumption | Resident | Reference |
|---|---|---|
| Soil Ingestion | 114 mg-yr/kg-day<br>(age adjusted) | MDNR 1995 |
| Dermal Contact Rate | 353 mg-yr/kr-day<br>(age adjusted) | MDEQ 2000 |
| Inhalation Rate | 7.52 $m^3$-yr/kg-day<br>(age adjusted) | MDNR 1995 |
| Age | 1-31 years | EPA 1997 |
| Fraction from Contaminated Source | 1.0 | Site-Specific |
| Exposure Frequency | 350 days/year (ingestion)<br>245 days/year (dermal) | MDNR 1995 |
| Exposure Duration | 30 years (cancer)<br>30 years (noncancer)<br>2 years (reproductive) | EPA 1997 |
| Absorption Efficiency | 0.14 | EPA 1998 |

**Table E-4 Recreational Exposure Assumptions**

| Assumption | Resident | Reference |
|---|---|---|
| Soil Ingestion | 2.8 mg-yr/kg-day<br>47 mg-yr/kg-day<br>34 mg-yr/kg-day | MDNR 1995 |
| Dermal Contact Rate | 85 mg-yr/kg-day<br>61 mg-yr/kg-day | EPA 1997b |
| Inhalation Rate | 1.37 $m^3$-yr/kg-day<br>1.9 $m^3$-yr/kg-day | EPA 1997b |
| Age | 6 - 31 years | |
| Fraction from Contaminated Source | 1.0 | Site-Specific |
| Exposure Frequency | 128 days | MDEQ 2000 |
| Exposure Duration | 2 years (reproductive)<br>24 years (immunological)<br>24 years (cancer) | EPA 1997b<br>EPA 1997b<br>EPA 1996 |
| Absorption Efficiency | 0.14 | EPA 1998 |

Risk Characterization combines information from the data evaluation, toxicity assessment, and exposure assessment to develop estimates of cancer risk and noncancer hazard. Cancer risks are expressed as a probability of an individual developing cancer from site-related exposures, or in this case, from ingesting fish or being exposed to floodplain soil. Noncancer risk is expressed as a hazard index, which is a ratio of the estimated dose of PCBs received from an exposure to the RfD, which is the dose below which adverse effects are not expected. Two noncancer endpoints were evaluated — reproductive health effects and immunological health effects.

EPA has established an acceptable target range for carcinogenic risk of 1 in one million to 1 in 10,000, while for all Superfund sites, the acceptable risk level is established by the EPA Regional Administrator on a case-by-case basis. The Michigan

Department of Environmental Quality (MDEQ) considers risk below 1 in 100,000 to be acceptable. Both EPA and MDEQ consider hazard quotients / indices at or below 1 to be acceptable.

# Summary of HHRA Results

Tables E-5 through E-10 summarize estimated risks and hazards for sport and subsistence anglers, residents, and recreationalists.

## Risks and Hazards for Anglers

Tables E-5 and E-6 present risks and hazards for anglers based on average and maximum fish concentrations, respectively.

Using both average and maximum fish concentrations, cancer risks for subsistence anglers in all study areas were outside (greater than) the EPA target cancer risk range of 1 in 1 million to 1 in 10,000 and above the MDEQ risk threshold of 1 in 100,000. Hazard quotients for subsistence anglers in all study areas were greater than the acceptable EPA and MDEQ hazard quotient threshold of 1.

Using both average and maximum fish concentrations, cancer risks for both central tendency and high end sport anglers who consumed 100 percent smallmouth bass or 76 percent smallmouth bass and 24 percent carp were outside the EPA target cancer risk range and exceeded the MDEQ cancer threshold for all ABSAs with two exceptions. Cancer risks calculated using both average and maximum PCB concentrations for central tendency sport anglers consuming 100 percent smallmouth bass from ABSAs 6 and 11 were in excess of the MDEQ cancer threshold but below 1 in 10,000 (i.e., the upper limit of the USEPA range).

Using both average and maximum fish concentrations, hazard quotients for both central tendency and high end sport anglers who consume either 100 percent smallmouth bass or 76 percent smallmouth bass and 24 percent carp exceeded the EPA and MDEQ hazard quotient threshold of 1 for both the immunological and reproductive endpoints with one exception. The hazard quotient (0.8) using average concentrations for the central tendency sport angler who consumes 100 percent smallmouth bass from ABSA 11 does not exceed the hazard quotient threshold for the reproductive endpoint.

## Risks and Hazards for Residents and Recreationalists

Tables E-7 and E-8 present risks and hazards for residents based on average and maximum concentrations, respectively. Table E-9 and E-10 present risks and hazards for recreationalists based on average and maximum concentrations, respectively.

Using average floodplain soil concentrations, cancer risks to residents in all three floodplain soil areas were within the EPA target cancer risk range of 1 in 1 million to 1 in 10,000, but above the MDEQ cancer risk threshold of 1 in 100,000. Using

maximum floodplain soil concentrations, cancer risks were outside the EPA target cancer risk range and exceeded the MDEQ threshold.

Using both average and maximum floodplain soil concentrations, hazard indices based on immunological endpoints for residents in all three floodplain soil areas exceeded the EPA and MDEQ hazard index threshold of 1. Hazard indices (HIs) were calculated for residential and recreationalist receptors due to the summation of HQs for multiple exposure routes (i.e., ingestion, dermal contact, and inhalation of fugitive dust). Hazard indices for the reproductive endpoint exceeded 1 using maximum concentrations for all three areas. Hazard indices for the reproductive endpoint using average concentrations did not exceed 1.

**Table E-5 Summary of Risks and Hazards for Subsistence and Sport Anglers Average Concentrations API/PC/KR Site**

| | | | | Carcinogenic Risk from Ingestion of Fish | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Subsistence | | Sport - Central Tendency | | Sport - High-End | |
| Source Medium | Exposure Medium | Exposure Point | Chemical | 100% SMB | 76% SMB/ 24% Carp | 100% SMB | 76% SMB/ 24% Carp | 100% SMB | 76% SMB/ 24% Carp |
| Fish | Fish | ABSA 3,4,5 (Combined) | Total PCBs | 7.6E-04 | 1.3E-03 | 1.0E-04 | 1.7E-04 | 2.7E-04 | 4.5E-04 |
| | | ABSA 6 | Total PCBs | 6.7E-04 | 1.1E-03 | 9.0E-05 | 1.4E-04 | 2.3E-04 | 3.7E-04 |
| | | ABSA 7 | Total PCBs | 1.0E-03 | 1.2E-03 | 1.4E-04 | 1.6E-04 | 3.5E-04 | 4.2E-04 |
| | | ABSA 8 | Total PCBs | 1.3E-03 | 1.8E-03 | 1.8E-04 | 2.4E-04 | 4.6E-04 | 6.1E-04 |
| | | ABSA 9 | Total PCBs | 2.2E-03 | 2.0E-03 | 3.0E-04 | 2.7E-04 | 7.8E-04 | 7.0E-04 |
| | | ABSA 10 | Total PCBs | 1.3E-03 | 2.2E-03 | 1.7E-04 | 3.0E-04 | 4.5E-04 | 7.8E-04 |
| | | ABSA 11 | Total PCBs | 3.7E-04 | 1.1E-03 | 4.9E-05 | 1.5E-04 | 1.3E-04 | 3.8E-04 |

Notes: Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)

| | | | | Noncarcinogenic Hazard Quotient from Ingestion of Fish | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Subsistence | | Sport - Central Tendency | | Sport - High End | |
| Source Medium | Exposure Medium | Exposure Point | Chemical | 100% SMB | 75% SMB/ 25% Carp | 100% SMB | 75% SMB/ 25% Carp | 100% SMB | 75% SMB/ 25% Carp |
| Fish | Fish | ABSA 3,4,5 (Combined) | Total PCBs | 13 (R)<br>71 (I) | 21 (R)<br>75 (I) | 1.7 (R)<br>5.9 (I) | 2.9 (R)<br>10 (I) | 4.4 (R)<br>15 (I) | 7.5 (R)<br>26 (I) |
| | | ABSA 6 | Total PCBs | 11 (R)<br>39 (I) | 18 (R)<br>63 (I) | 1.5 (R)<br>5.3 (I) | 2.4 (R)<br>8.4 (I) | 3.9 (R)<br>14 (I) | 6.2 (R)<br>22 (I) |
| | | ABSA 7 | Total PCBs | 17 (R)<br>59 (I) | 20 (R)<br>70 (I) | 2.3 (R)<br>7.9 (I) | 2.7 (R)<br>9.4 (I) | 5.9 (R)<br>21 (I) | 7.0 (R)<br>25 (I) |
| | | ABSA 8 | Total PCBs | 22 (R)<br>77 (I) | 29 (R)<br>100 (I) | 3.0 (R)<br>10 (I) | 3.9 (R)<br>14 (I) | 7.7 (R)<br>27 (I) | 10 (R)<br>36 (I) |
| | | ABSA 9 | Total PCBs | 37 (R)<br>130 (I) | 33 (R)<br>120 (I) | 5.0 (R)<br>18 (I) | 4.5 (R)<br>16 (I) | 13 (R)<br>46 (I) | 12 (R)<br>41 (I) |
| | | ABSA 10 | Total PCBs | 21 (R)<br>75 (I) | 37 (R)<br>130 (I) | 2.9 (R)<br>10 (I) | 5.0 (R)<br>17 (I) | 7.5 (R)<br>26 (I) | 13 (R)<br>45 (I) |
| | | ABSA 11 | Total PCBs | 6.1 (R)<br>21 (I) | 18 (R)<br>63 (I) | .82 (R)<br>2.9 (I) | 2.4 (R)<br>8.5 (I) | 2.1 (R)<br>7.5 (I) | 6.3 (R)<br>22 (I) |

Notes: Target hazard quotient: 1.0 (EPA and MDEQ)
(R): Reproductive endpoint
(I): Immunological endpoint

Using average floodplain soil concentrations, cancer risks to recreationalists in all three floodplain areas were within the EPA target risk range and below the MDEQ cancer risk threshold. Using maximum floodplain soil concentrations, cancer risks were within the EPA target risk range but above the MDEQ cancer risk threshold. The highest cancer risk using maximum concentrations was estimated for the Plainwell area where cancer risks were 4 in 100,000.

**Table E-6 Summary of Risks and Hazards for Subsistence and Sport Anglers Maximum Concentrations API/PC/KR Site**

| | | | | **Carcinogenic Risk from Ingestion of Fish** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Subsistence** | | **Sport - Central Tendency** | | **Sport - High End** | |
| **Source Medium** | **Exposure Medium** | **Exposure Point** | **Chemical** | **100% SMB** | **76% SMB/ 24% Carp** | **100% SMB** | **76% SMB/ 24% Carp** | **100% SMB** | **76% SMB/ 24% Carp** |
| Fish | Fish | ABSA 3,4,5 (Combined) | Total PCBs | 2.7E-03 | 4.8E-03 | 3.6E-04 | 6.5E-04 | 9.3E-04 | 1.7E-03 |
| | | ABSA 6 | Total PCBs | 2.5E-03 | 3.2E-03 | 3.3E-04 | 4.3E-04 | 8.7E-04 | 1.1E-03 |
| | | ABSA 7 | Total PCBs | 2.5E-03 | 3.0E-03 | 3.4E-04 | 4.0E-04 | 8.9E-04 | 1.0E-03 |
| | | ABSA 8 | Total PCBs | 2.9E-03 | 3.7E-03 | 3.8E-04 | 5.0E-04 | 1.0E-03 | 1.3E-03 |
| | | ABSA 9 | Total PCBs | 4.0E-03 | 4.1E-03 | 5.3E-04 | 5.5E-04 | 1.4E-03 | 1.4E-03 |
| | | ABSA 10 | Total PCBs | 1.6E-03 | 4.0E-03 | 2.2E-04 | 5.4E-04 | 5.8E-04 | 1.4E-03 |
| | | ABSA 11 | Total PCBs | 5.7E-04 | 1.9E-03 | 7.6E-05 | 2.6E-04 | 2.0E-04 | 6.7E-03 |

Notes: Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)

| | | | | **Noncarcinogenic Hazard Quotient from Ingestion of Fish** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Subsistence** | | **Sport - Central Tendency** | | **Sport - High End** | |
| **Source Medium** | **Exposure Medium** | **Exposure Point** | **Chemical** | **100% SMB** | **75% SMB/ 25% Carp** | **100% SMB** | **75% SMB/ 25% Carp** | **100% SMB** | **76% SMB/ 24% Carp** |
| Fish | Fish | ABSA 3,4,5 (Combined) | Total PCBs | 44 (R)<br>150 (I) | 80 (R)<br>280 (I) | 5.9 (R)<br>21 (I) | 11 (R)<br>38 (I) | 15 (R)<br>54 (I) | 28 (R)<br>98 (I) |
| | | ABSA 6 | Total PCBs | 42 (R)<br>150 (I) | 53 (R)<br>190 (I) | 5.6 (R)<br>20 (I) | 7.2 (R)<br>25 (I) | 15 (R)<br>51 (I) | 19 (R)<br>65 (I) |
| | | ABSA 7 | Total PCBs | 42 (R)<br>150 (I) | 50 (R)<br>170 (I) | 5.7 (R)<br>20 (I) | 6.7 (R)<br>23 (I) | 15 (R)<br>52 (I) | 17 (R)<br>61 (I) |
| | | ABSA 8 | Total PCBs | 48 (R)<br>170 (I) | 62 (R)<br>220 (I) | 6.4 (R)<br>22 (I) | 8.4 (R)<br>29 (I) | 17 (R)<br>58 (I) | 22 (R)<br>76 (I) |
| | | ABSA 9 | Total PCBs | 66 (R)<br>230 (I) | 68 (R)<br>240 (I) | 8.8 (R)<br>31 (I) | 9.1 (R)<br>32 (I) | 23 (R)<br>81 (I) | 24 (R)<br>83 (I) |
| | | ABSA 10 | Total PCBs | 27 (R)<br>96 (I) | 67 (R)<br>240 (I) | 3.7 (R)<br>13 (I) | 9.0 (R)<br>32 (I) | 9.6 (R)<br>34 (I) | 23 (R)<br>82 (I) |
| | | ABSA 11 | Total PCBs | 9.4 (R)<br>33 (I) | 32 (R)<br>110 (I) | 1.3 (R)<br>4.4 (I) | 4.3 (R)<br>15 (I) | 3.3 (R)<br>12 (I) | 11 (R)<br>39 (I) |

Acceptable hazard quotient: 1.0 (EPA and MDEQ)
(R): Reproductive endpoint
(I): Immunological endpoint

**Table E-7 Summary of Risks and Hazards for Residents Living Near Exposed Floodplain Soils Average Concentrations API/K/KR Site**

| Source Medium | Exposure Medium | Exposure Point | Chemical | Carcinogenic Risk: Exposure Routes Total | Chemical | Noncarcinogenic Hazard Index: Exposure Routes Total |
|---|---|---|---|---|---|---|
| Floodplain Soils | Floodplain Soils | Trowbridge | Total PCBs | 5.0E-05 | Total PCBs | 0.84 (R)<br>2.9 (I) |
| Floodplain Soils | Floodplain Soils | Otsego | Total PCBs | 3.4E-05 | Total PCBs | 0.57 (R)<br>2.0 (I) |
| Floodplain Soils | Floodplain Soils | Plainwell | Total PCBs | 4.4E-05 | Total PCBs | 0.74 (R)<br>2.6 (I) |

Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)
Acceptable hazard index: 1.0 (EPA and MDEQ)
(R): Reproductive endpoint
(I): Immunological endpoint

**Table E-8 Summary of Risks and Hazards for Residents Living Near Exposed Floodplain Soils Maximum Concentrations API/PC/KR Site**

| Source Medium | Exposure Medium | Exposure Point | Chemical | Carcinogenic Risk: Exposure Routes Total | Chemical | Noncarcinogenic Hazard Index: Exposure Routes Total |
|---|---|---|---|---|---|---|
| Floodplain Soils | Floodplain Soils | Trowbridge | Total PCBs | 3.3E-04 | Total PCBs | 5.5 (R)<br>19 (I) |
| Floodplain Soils | Floodplain Soils | Otsego | Total PCBs | 1.5E-04 | Total PCBs | 2.4 (R)<br>8.5 (I) |
| Floodplain Soils | Floodplain Soils | Plainwell | Total PCBs | 3.5E-04 | Total PCBs | 5.8 (R)<br>20 (I) |

Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)
Acceptable hazard index: 1.0 (EPA and MDEQ)
(R): Reproductive endpoint
(I): Immunological endpoint

**Table E-9 Summary of Risks and Hazards for Recreational Visitors to Exposed Floodplain Soils Average Concentrations API/K/KR Site**

| Source Medium | Exposure Medium | Exposure Point | Chemical | Carcinogenic Risk: Exposure Routes Total | Chemical | Noncarcinogenic Hazard Index: Exposure Routes Total |
|---|---|---|---|---|---|---|
| Floodplain Soils | Floodplain Soils | Trowbridge | Total PCBs | 5.3E-06 | Total PCBs | 0.008 (R)<br>0.39 (I) |
| Floodplain Soils | Floodplain Soils | Otsego | Total PCBs | 3.6E-06 | Total PCBs | 0.006 (R)<br>0.26 (I) |
| Floodplain Soils | Floodplain Soils | Plainwell | Total PCBs | 4.7E-06 | Total PCBs | 0.008 (R)<br>0.34 (I) |

Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)
Acceptable hazard index: 1.0 (EPA and MDEQ)

**Table E-10 Summary of Risks and Hazards for Recreational Visitors to Exposed Floodplain Soils Maximum Concentrations API/PC/KR Site**

| Source Medium | Exposure Medium | Exposure Point | Chemical | Carcinogenic Risk: Exposure Routes Total | Chemical | Noncarcinogenic Hazard Index: Exposure Routes Total |
|---|---|---|---|---|---|---|
| Floodplain Soils | Floodplain Soils | Trowbridge | Total PCBs | 3.5E-05 | Total PCBs | 0.58 (R)<br>2.5 (I) |
| Floodplain Soils | Floodplain Soils | Otsego | Total PCBs | 1.5E-05 | Total PCBs | 0.26 (R)<br>1.1 (I) |
| Floodplain Soils | Floodplain Soils | Plainwell | Total PCBs | 3.7E-05 | Total PCBs | 0.61 (R)<br>2.7 (I) |

Target cancer risk range: 1E-06 to 1E-04 (EPA); 1E-05 (MDEQ)
Acceptable hazard index: 1.0 (EPA and MDEQ)

Using average floodplain soil concentrations, hazard indices based on both the immunological and reproductive endpoints were below the EPA and MDEQ threshold of 1.0. Using maximum concentrations, hazard indices based on the immunological endpoint exceeded the EPA and MDEQ threshold for the Plainwell (2.7), Otsego (1.1) and Trowbridge (2.5) areas. Using maximum concentrations, hazard indices based on the reproductive endpoint were all below the hazard index threshold.

## Risk-Based Concentrations for Fish, Sediments and Floodplain Soils

Risk-based fish concentrations ($RBC_{fish}$) and sediment concentrations ($RBC_{sed}$) were developed to be protective of sport and subsistence anglers. Risk-based floodplain soil concentrations ($RBC_{soil}$) were developed to be protective of residents living near exposed floodplain soil. RBCs were developed for both cancer and noncancer endpoints. Risk-based concentrations were developed for PCBs using an allowable cancer risk of 1 in 100,000 and a noncancer hazard index of 1.0.

## RBCs for Fish Tissue

Table E-11 presents risk-based and hazard-based fish concentrations ($RBC_{fish}$). For central tendency sport anglers who consume up to 24 meals per year of fish, a fish concentration of 0.109 mg/kg in fillets is protective of cancer endpoints, a concentration of 0.187 mg/kg in fillets is protective of the noncancer immunological endpoint. Since the immunological endpoint is more protective than the reproductive endpoint and is always a lesser concentration, the reproductive endpoint was not calculated. For high-end sport anglers who consume up to 125 meals/year of fish, a fish concentration of 0.042 is protective of cancer endpoints, a concentration of 0.072 is protective of the noncancer immunological endpoint. For subsistence anglers who consume up to 179 meals per year, a fish concentration of 0.015 mg/kg is protective of cancer endpoints, 0.025 mg/kg is protective of the noncancer immunological.

**Table E-11 Risk-Based Fish Fillet Concentrations ($RBC_{fish}$) [1] API/PC/KR Site**

| Receptor | $RBC_{fish}$ Protective of 1E-05 Cancer Risk for PCBs (mg/kg) | $RBC_{fish}$ Protective of 1.0 Hazard Index for PCBs (mg/kg) |
|---|---|---|
| Sport Angler - Central Tendency<br>Assumes 24 meals/year<br>0.015 kg/day | 0.109 | 0.187 |
| Sport Angler - High End<br>Assumes 125 meals/year<br>0.078 kg/day | 0.042 | 0.072 |
| Subsistence Angler<br>Assumes 179 meals/year<br>0.11 kg/day | 0.015 | 0.025 |

[1] Concentrations protective of both carp and smallmouth bass (fish consumption was assumed to consist of 76% bass and 24% carp). Hazard index for immunological endpoint. Because $RBC_{fish}$ based on immunological toxicity are lower than those based on reproductive toxicity, only $RBC_{fish}$ for the immunological endpoint are presented.

For comparison, the MDCH considers their PCB fish advisory concentration of less than or equal to 0.05 mg/kg in fish to be protective at an ingestion rate of 225 meals per year (0.14 kg/day) for the general population for noncancer endpoints. The MDCH does not base its advisory on cancer risk, due to political and pragmatic considerations. For subsistence anglers, $RBC_{fish}$ developed in this HHRA indicate that concentrations in the range of 0.015 (cancer) and 0.025 (noncancer) are needed to be protective of health. Differences between the derivations of the two noncancer values are listed in Table E-12.

**Table E-12 Comparison of MDCH and HHRA Assumptions**

| | MDCH | HHRA |
|---|---|---|
| Meals/year | 225 | 179 |
| Average daily fish consumption (kg) | 0.14 | 0.11 |
| Reduction by cleaning/cooking (%) | 50 | 50 |
| Weight of subject (kg) | 70 | 70 |
| Target dose, HPV or RfD (µg/kg/day) | 0.05 | 0.02 |
| PCB level in fish (mg/kg) | 0.05 | 0.025 |

Most of the difference between the two results can be attributed to the difference between the health protection value (HPV) used by the MDCH (0.05 mg/kg/day) and the EPA RfD used in the HHRA (0.02 mg/kg/day). These values were derived from the same data by different methodologies. The Great Lakes Fish Advisory Task Force used a "weight of evidence" approach to derive the HPV used by the MDCH from data on a wide range of health effect endpoints. The EPA derives RfDs from data on specific endpoints with uncertainty and modifying factors added.

The MDCH Division of Environmental Epidemiology has reviewed this document and considers it to be adequately consistent with the MDCH protocol for issuing fish consumption advisories. Although there are differences between the cleanup levels and the MDCH first Level of Concern as cited above, MDCH considers the

parameters and assumptions used in the two derivations are reasonable, the resulting levels to be reasonably close, and the cleanup levels to be more protective than the MDCH Level of Concern. MDCH acknowledges the EPA and MDEQ's authority to establish the cleanup levels to be used at any site.

## RBCs for In-Stream Sediments

Table E-13 presents the risk-based and hazard-based sediment concentrations ($RBC_{soil}$). $RBC_{fish}$ were used to develop $RBC_{sed}$. $RBC_{sed}$ represent the sediment concentrations protective of fish that are consumed at the ingestion rates specified for sport and subsistence anglers. $RBC_{sed}$ were developed using the biota-to-sediment accumulation factor (BSAF) method presented in Region V EPA guidance (Pelka 1998). $RBC_{sed}$ using the MDEQ cancer threshold as the target cancer risk range from 0.51 mg/kg protective of sport anglers who consume 100 percent game fish such as bass to 0.04 mg/kg protective of subsistence anglers who consume 76 percent smallmouth bass and 24 percent bottom feeding fish such as carp. $RBC_{sed}$ using the MDEQ and USEPA noncancer hazard quotient threshold of 1.0 as the target HQ range from 0.88 mg/kg for sport anglers consuming 100 percent bass to 0.07 mg/kg for subsistence anglers assumed to consume 76 percent bass and 24 percent carp.

**Table E-13 Risk-Based Sediment Concentration ($RBC_{sed}$) Protective of Smallmouth Bass and Carp (mg/kg sediment) API/PC/KR Site**

| Scenario | $RBC_{sed}$ Protective of Fish Ingestion at 1E-05 Cancer Risk for PCBs (mg/kg) | | $RBC_{sed}$ Protective of Fish Ingestion at 1.0 Hazard Quotient for PCBs (mg/kg) | |
|---|---|---|---|---|
| | Bass | Bass/Carp | Bass | Bass/Carp |
| Sport Angler - Central Tendency | 0.51 | 0.30 | 0.88 | 0.52 |
| Sport Angler - High End | 0.20 | 0.12 | 0.34 | 0.20 |
| Subsistence Angler | 0.07 | 0.04 | 0.12 | 0.07 |

## RBC for Floodplain Soil

Table E-14 presents the risk-based floodplain soil concentration ($RBC_{soil}$) protective of residents. These $RBC_{soil}$ would be protective of residents exposed to contaminated soil via ingestion, dermal contact, and inhalation. For the cancer endpoint the $RBC_{soil}$ is 2.5 mg/kg. For noncancer endpoints, the $RBC_{soil}$ is 15 mg/kg for the reproductive endpoint and 4 mg/kg for the immunological endpoint.

**Table E-14 Risk-Based Floodplain Soil Concentrations ($RBC_{soil}$) Protective of Residents API/PC/KR Site**

| Receptor | $RBC_{soil}$ Protective of 1E-05 Cancer Risk (mg/kg) | $RBC_{soil}$ Protective of 1.0 Hazard Index (mg/kg) |
|---|---|---|
| Resident | 2.5 | 15 (R)<br>4.0 (I) |

Notes (R) = Reproductive endpoint
(I) = Immunological endpoint

Table E-15 presents the risk-based floodplain soil concentration ($RBC_{soil}$) protective of recreationalists. These $RBC_{soil}$ would be protective of recreationalists exposed to contaminated soil via ingestion, dermal contact, and inhalation. For the cancer endpoint, the $RBC_{soil}$ is 23 mg/kg. For noncancer endpoints, the $RBC_{soil}$ is 139 mg/kg for the reproductive endpoint and 32 mg/kg for the immunological endpoint.

**Table E-15 Risk-Based Floodplain Soil Concentrations ($RBC_{soil}$) Protective of Recreational Visitors API/PC/KR Site**

| Receptor | $RBC_{soil}$ Protective of 1E-05 Cancer Risk (mg/kg) | $RBC_{soil}$ Protective of 1.0 Hazard Index (mg/kg) |
|---|---|---|
| Resident | 23 | 139 (R)<br>32 (I) |

Notes: (R) = Reproductive endpoint
(I) = Immunological endpoint

As with any health risk assessment, exposure assumptions made introduce uncertainty into the results and conclusions. This uncertainty does not, however, preclude use of HHRA results in risk management decisions. In particular, the HHRA is believed to provide a range of risks and hazards that are conservative (i.e., likely to err on the side of protection of human health).